

# MEC-E7003 Manufacturing Methods II

INFO 2<sup>nd</sup> of March 2021

Changes possible  
due to Covid-19 situation

# Today's Agenda

- What is this course about ?
- Course timetable, structure, safety, policy etc.

# Mandatory prerequisite

- **MEC-1080 Production Engineering**
- **MEC-E7002 Manufacturing methods I (ongoing) must be started in period III at the latest**

# Teachers

- Juha Huuki
- Pekka Kyrenius
- Rizwan Ullah
- `firstname.lastname@aalto.fi`

# Course overview

- **Credits:** 5 credits
- a master's level course
- to familiarize students with the research lab environment as well as research methods
- All the information: Shared through  
**[https:// Mycourses.aalto.fi](https://mycourses.aalto.fi)**

# Learning outcomes

Student:

- knows the basics of NC-and CAD/CAM-programming including industrial robots.
- is able to apply knowledge and skills previously taught in the field of production engineering.
- is able to design and conduct small-scale empirical research.
- is able to produce a written research report based on the results of the research.
- has learned collaborative skills in laboratory exercises and writing reports as a part of a small group.

# Assignment guideline

- Fixed size groups of 4 students (grouping in MyCourses)
- Total of 4 assignments:
  1. NC-lathe
  2. Robot
  3. Machining research
  4. CAM
- Assignment (except CAM) have different task i.e teams-meetings for every group and written research report
- Each assignment must be done by the whole group

# Assignment scheduling

(A more detailed information for some assignment is given separately)

- Materials in MyCourses:
  - Instructions for assignments
  - The proposed schedule of laboratory exercises for each group (Adjustment of scheduled times will be agreed separately.)



# NC Machining Process

- The basic NC machining process includes the following stages:
- Designing the CAD model
- Converting the CAD file to a NC program
- Preparing the NC machine
- Executing the machining operation

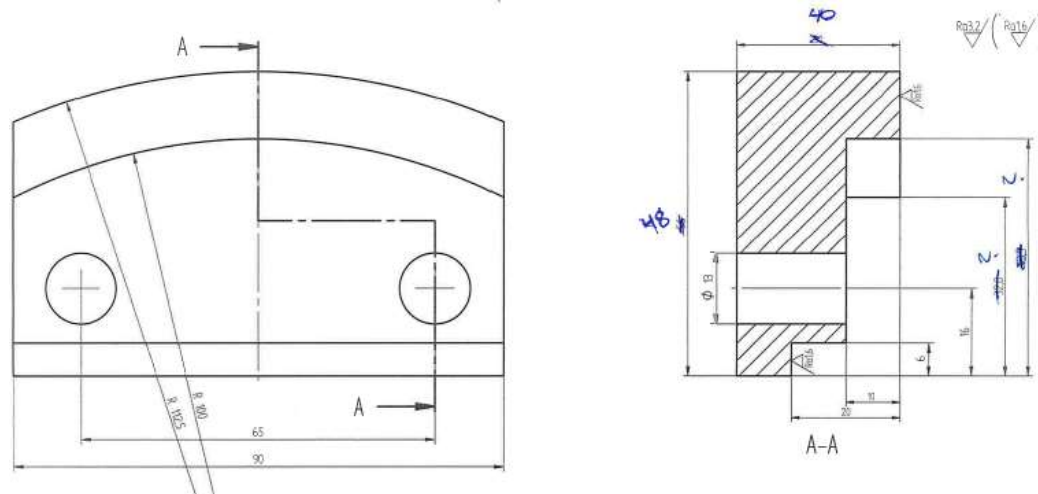
# 1. CAM simulation

The deadline of CAM assignment is 25th of May 2021.

- The group designs the machining simulation model including NC code for workpiece using some CAM-software. Strongly recommended to use i.e Creo.
- The group makes also manufacturing plans for workpiece using manufacturing template.
- The workpiece is: Clamp swivel base part number art.367

<http://www.gerardispa.com/media/documents/catalogues/workholding/04.pdf>

Update the drawing and use the follow dimensions and add



# Manufacturing plan

Manufacturing plan Group x	Part name							Base, dwg # 1002									
	Material							UNI Fe52 (low-alloy steel)									
	Sandvik CMC:							02.1									
	# of pieces							20									
	Phase of work							machining									
	Machine tool:							Horizontal machining center									
	Fixture:							Machine vise									
	Fixture stop points							side stop									
		preparation base time								5280							
		help time coefficient (prep.)								1,25							
		preparation time								6600							
		cutting time								564							
	aux time								176								
	help time coefficient								1,2								
	cycle time per piece								7488								
	total work time								41,6	hours							

# NC-lathes



The estimated machine time: x min x sec

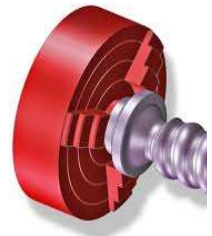
# Part II NC-lathe / Okuma exercise

- Every group design the part for NC-Okuma exercise. Show this part in Teams meeting
- Scheduling for groups, see timetable from MyCourses.
- The workpiece features must include: chamfer, external turning, grooving and thread.

# NC-lathe / Okuma part II continue



- Write a program for the OKUMA with notepad using the template.
- Calculate total time for lathe operations
- **Task: a drawing, setup sheet, calculated machine time and NC-program.**
- Use time and effort to make NC-program
- Upload task to Mycourses:  
drawing, setup sheet, machining time and NC program. Write the report  
The deadline of Okuma part II assignment is 28th of May 2021.





# Programming the Okuma device:

## Writing a program for the OKUMA

- The tools used in this work are at the Okuma tools locations `x, x, 1x`. Tool no. 9 is a zero set tool and a finishing tool
- Find the cutting data from the Sandvik Coromant Turning manual. The material is hardened steel.
- The Okuma machine is controlled by a subroutine NLAP function. This means that the groups writing the program define the basic form of the machined piece and give the starting point of the machining. The machine's controller calculates the necessary toolpaths according to the given cutting data. An NLAP An NLAP function/subroutine is also used for the finishing. The program template is shown below (Note: All of the points are not shown in the example; the missing items are marked by a question mark (?)). Search for the missing information from Okuma Programming Manual folder, or complete the code yourself.

```
%  
O1234 (Ei nolla vaan O niin kuin ohjelma. Pakollinen alussa)  
N10 G50 S3000  
N20 M90  
N30 G90 M42  
NLAP1 G81 (Muodon määrittäminen alkaa NLAP k.s. Prg.Man. s.235-244)  
N33 G01 G42 X? Z0 F0.? (Työkalun kompensatio oikealle G42)  
N40 G01 X? Z-?  
N50 G01 Z-?  
N52 G01 X? Z-?  
N60 G02 X? Z-? I? K? (Kaaret G02 ja G03 k.s Prg.Man. sivut 82-86)  
N70 G01 Z-?  
N100 G01 X? Z-?  
N102 Z22  
N104 Z22  
N106 J0.5 (Muoto riippuu tietty kappaleestanne)  
N110 G40 (Kompensatiot pois G40. Käsky pitää olla omalla rivillä)  
N112 G80 (NLAP muodonmäärittäksen loppu)  
N120 G00 X500 Z250 (Työkalunvaihtopisteeseen pikaliikkeellä)  
N125 T080808 (Rouhintatyökalun vaihto paikasta 8)  
N130 G96 S22 M42 M03 (Vakiolast nopeus G96. Sandvik sorvaustyökalut)  
N140 G01 X? Z? M08 F2 (Siirrytään lastuamisen aloitus pisteeseen)  
N150 G95 NLAP1 D2 F0.? U0.? M0.2 (NLAP rouhinta kutsu)  
N170 G00 X500 Z250 (Taas työkalunvaihtopisteeseen)  
N180 T090909 (Viimeistelytyökalu)  
N190 G96 S? M42 M03 (Uusi työkalu uudet lastuamisarvot)  
N200 G01 X? Z? M08 F2 (Aloituspisteeseen)  
N210 G87 NLAP1 (Viimeist kiertö. Syöttö määritetty rivillä N33 F0.?)  
N230 G00 X500 Z250  
N240 T121212 (Pistotyökalu)
```

```
N250 G96 S? M42 M03 (Pistotyökalun lastuamisarvot)  
N270 G01 X? Z-? M08 F2 (Lähestytään)  
N280 G01 X? F0.? (Pistetään)  
N290 G01 X? F? M09 (Poistutaan ylös)  
N300 G00 X500 Z250 M05  
N310 T020202 (Kierteistystyökalu)  
N320 G96 S?? M42 M03  
N340 G01 X? Z-? M08 F2 (Lähestytään)  
N370 G33 X? Z-? F? (Kierteitys k.s. Prg. Man s. 87-89)  
N380 X? (Kierrettä ei lastuta kerralla)  
N390 X? (vaan käytetään useita)  
N392 X? (kiertoja)  
N393 X?  
N395 X? (joissa lastuamissyvyys)  
N396 X? (pienenee loppua)  
N398 X?  
N398 X? (kohden)  
N400 G00 X500 Z250 M05 M09  
N500 M91  
N600 M02 (Ohjelman lopetuskäsky)  
%
```

- The programmable zero-point of the piece is located on the front face of the piece. This frontal surface does not need to be adjusted in the program, because it is typically already adjusted in the time setting (Does not always apply to serial production).
- The program is written in WordPad or Notepad.
- The thread is made on the front end of the piece due to the structure. The thread is selected from a range of 1.5 – 3 mm.
- Programming is done using an NLAP. As the machine program memory is very small, so very long programs cannot be loaded.
- Make notes during the work. The piece is set up, the tools are measured, and the program is run under the supervision of the staff.
- In case of problems just ask for help from the staff



# Okuma's work report

- Should included the following elements:
- 1 INTRODUCTION Work background,goals,etc.
- 2 The theory
- Theory of lathes and turning, especially in NC -lathes. Theory of NC-programming and tools etc.
- 3 APPLIED PART Used Equipment
- Used tools,cutting data,toolpaths Okuma's NC program description
- 4 SUMMARY
- 5 REFERENCES
- ATTACHMENTS
- The length of the report(max 12 pages)

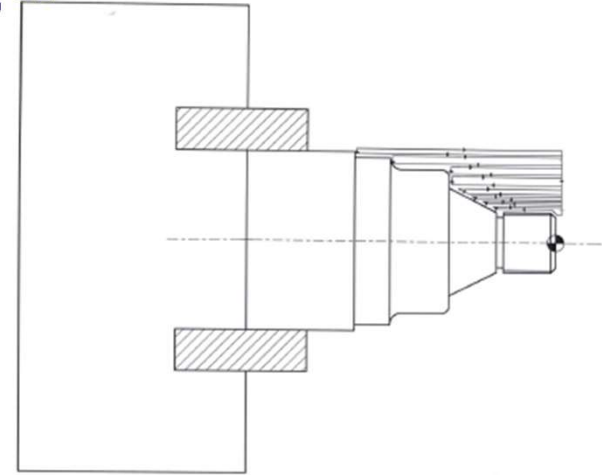
# Excursio to ABB Oy, Robotics Vantaa or Helsinki

Excursio to ABB robotics 6 May 2020. Workgroups 1-3:  
08:30-10 and groups 4-7: 10-11:30

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Robotics
ABB Oy
Riihimiehentie 3
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# Calculate total time for machining

- Using CAM and formulas



# 3. Industrial robot (Fanuc)

- Instructor Pekka Kyrenius
- FEC system (Fanuc Education Cell)
- Intro to industrial robot operating, programming & testing
- Pick & place demo environment
- Modification of demo program
- Topics: frames (coordinate systems), tool (gripper) setup, robot registers
- Starts 10:15 am

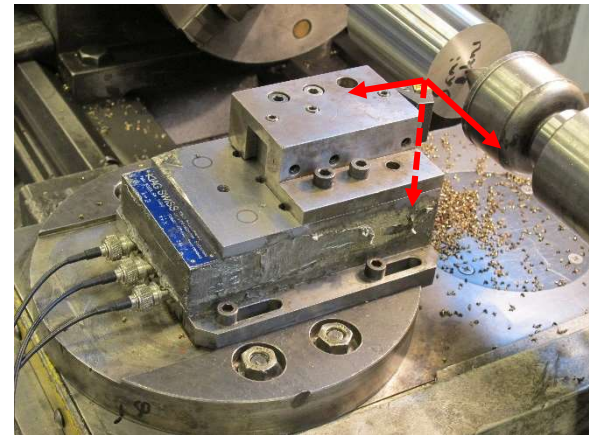


# 3. Industrial robot 2021

- Instructor Pekka Kyrenius
- Intro to industrial robotics
- Group based summary on instructor selected topic (4-6 text pages), email pdf-file to Pekka
- Remote presentation in Teams, 15 min, 5-7 slides with pictures, by one group member

# 4. Machining research

- Instructor: Rizwan Ullah
- Designing and performing cutting experiments in turning on a manual lathe.
- Title: Examining the effects of cutting parameters on cutting forces.
- Pre-requisite questions and tasks:
  - both student- and group-specific (see Instructions in MyCourses)
  - **Answers must be uploaded to MyCourses at the latest the day before the actual Teams meeting**
  - The answers and related theory are discussed in the beginning of the exercise (Teams meeting).
- Meeting place and time: **Teams meeting at 10 a.m.** Tuesdays are reserved for MR.
- Writing final report and submitting to MyCourses two weeks from the exercise.



# NC-exam

- Pre-requisite exam includes the basic theory needed in this course.
- **Online examination will be held on Tuesday 16 th of March at 09.00 - 11.00. Questions will open in MyCourses**
- Book: Radhakrishnan, P., Subramanyan, S., & Raju, V. (2008). Cad/cam/cim. New Age International.  
Chapter 12: CNC Machine Tools (pp. 341-471)
- Link to e-book: <https://ebookcentral.proquest.com/lib/aalto-ebooks/detail.action?docID=437710>
- Questions are selected from the list in the end of Chapter 12. In addition, NC code identification task is included.
- Grading: failed/passed

# Written reports

- Research reports are written based on the laboratory exercises.
- Assignment-specific instructions of the reports are given separately.
- Groups should explain contribution of each member in the reports (i.e. who has done what).
- The grading of reports is primarily based on the first versions of the reports.
- The reports must be uploaded to MyCourses within two (2) weeks from the date of the actual exercise. Late submission will decrease the grade. Extra time for writing reports can be given on request.



# Grading

- Grading of assignments is based on written reports (mostly, grades, 0 - 5), pre-requisite tasks and activity in exercises.
- The (group-specific) course grade is the average of grades of all the assignments.

# Rules in the laboratory

- Manuals, folders etc. must not be taken out of the lab.
- Computers in lab are for practical working only and shall not be reserved and used for writing reports.
- Staff has a priority to use devices.
- Eating and drinking is not allowed in lab.
- Only 3D images, CAD/CAM files and NC programs are allowed to be stored to computer hard disks.
- Remember to have a memory stick and to take a backup of a file.

# K2 machine shop safety 1

- working alone in machine shop is forbidden
- machine tools may only be used by authorized personnel
- students must complete mandatory safety training and machine specific instruction before getting authorization for a specific machine tool or system

# K2 machine shop safety 2

- one K2 \*staff member\* must always be present on location to supervise
- student access is only during designated group work times
- never leave machine running unattended
- get clearance for use (setup & tools) from instructor

# K2 machine shop safety 3

- machine tool guards must be used, use chip/coolant shield
- use secure work-holding fixtures, remove spanner or chuck key
- protective gear (eyes & hearing) plus suitable clothing must be used, long hair must be tied back

# K2 machine shop safety 4

- Attachment (fixture) of work pieces and tools must be secure in order to prevent unfastening due to cutting forces
- Be extra careful when employing rapid feeds or tool changes operations
- Keep hands off moving parts when machine tool is in operation

# K2 machine shop safety 5

- get to know nearest first aid point and eye wash station as well as nearest exit routes in case of fire
- machine and surroundings (floor) must be cleaned afterwards
- remove chips only with hook and brush, do \*not\* use pressurized air

# K2 machine shop safety 6

- all tooling & equipment must be returned to right / proper places
- report tool damage, maintenance needs and safety concerns immediately to staff
- no eating or drinking at machine shop (room 105d is for coffee breaks).



# Organization of groups

- 4 person groups
  - Will be formed at info session
- Lottery of group slot
  - Each group get a lottery ticket
  - Group selects their preferred slot from remaining slots

# Organization of groups 2021

- Sign up in a free workgroup in MyCourses

MEC-E7003 Manufacturing Methods II workgroup schedule 2021, version below			Period IV														Period V					
group members:	email		week: 8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	22				
Workgroup 1									MR Tue			RO thu			OK thu							
Workgroup 2								MR tue			RO tue		OK thu									
Workgroup 3							MR Tue		Ok thu		RO thu											
Workgroup 4									RO thu		MR Tue	OK Thu										
Workgroup 5							OK Thu			RO wed		MR Tue										
Workgroup 6									RO wed		OK tue		MR Tue									
Workgroup 7							RO wed	OK thu							MR Tue							
MR=Machining research	Machining research		INFO		NC																	
CAM simulation	CAM toolpaths and simulation																					
RO=Robot	Robot presentation in teams																					
OK=Okuma exercise	NC-programming and turning																					
NC=NC-exam	Pre-requisite NC-Exam: week 11/2021																					
version 1: 2021-03-01, 11:00																						

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